

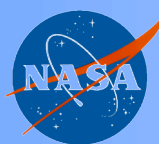
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AIRS - AMSR-E Total Water Vapor Comparisons

AIRS Science Team Meeting
May 3-6, 2005

Eric J. Fetzer
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JGR Paper in preparation:

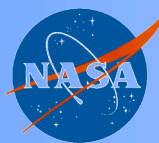
Comparison of Total Water Estimates from AIRS and AMSR-E

Eric J. Fetzer, H. H. Aumann, M. T. Chahine, Annmarie Eldering, Bjorn Lambrigtsen

Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA.

2 May 2005

In preparation for Journal of Geophysical Research-Atmospheres Special Section on AIRS
Validation



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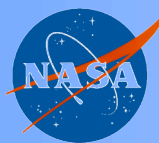
Approach and Goals

Approach

- Take advantage of AMSR-E strength: total water vapor for non-precipitating clouds.
 - ...but, AMSR-E calibration 'challenges' mean quantities are regressed against a variety of correlative data sets.

Goals of Comparison

1. Conditions giving consistency between the two data sets.
2. Quantify information added by infrared channels / cloud clearing.
3. Understand effects of HSB loss.
4. Scan-angle effects.
5. Climatological biases in mean fields.
 - For both microwave-only and full AIRS retrievals.
 - Implications for height-resolved water vapor climatologies and process studies.



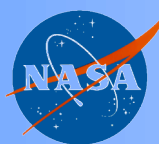
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The Advance Microwave Scanning Radiometer for Eos (AMSR-E)

- **A conically-scanning microwave radiometer on Aqua**
 - Follow-on to SSM/I
 - Constant emission angle
 - Sampling interval ~ 10 km, placed on 0.25 degree grid.
 - Over-ocean measurements of
 - Sea ice concentration
 - Cloud liquid water
 - Precipitation amount
 - Surface wind speed
 - Sea surface temperature
 - **Precipitable water vapor**
- *All over-water AIRS FOVs have matched, instantaneous AMSR-E observations (except at highest scan angles).*



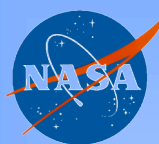
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Six Possible Cases for AIRS-AMSR Matches (by decreasing yield)

	<u>Case 1</u> MW-Only with AMSR	<u>Case 2</u> Full Ret with AMSR	<u>Case 3</u> AMSR Only	<u>Case 4</u> MW-Only No AMSR	<u>Case 5</u> Full Ret No AMSR	<u>Case 6</u> No Nothing
AIRS Full Retrieval <i>Qual_Cloud_OLR = 0</i> <i>Qual_Temp_Bot = 0</i>	No	Yes	No	No	Yes	No
AIRS MW Partial Retrieval <i>Qual_Cloud_OLR = 0</i> <i>Qual_Temp_Bot = 1</i>	Yes	No	No	Yes	No	No
AMSR-E Water Vapor Retrieval	Yes	Yes	Yes	No	No	No



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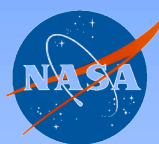


50S - 50N Over-Ocean Yields by Case (Percent of total counts) for Two Periods

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Total counts
2003.12.25- 2003.01.09	MW Ret w/AMSR	Full Ret w/AMSR	AMSR Only	MW Ret Only	Full Ret Only	No Nothing	
Combined	41	35	12	4	3	2	2,081,022
Day/Night	40 / 42	36 / 34	12 / 12	4 / 4	4 / 3	2 / 1	49 / 50
2003.05.01- 2003.05.16							
Combined	37	42	11	3	3	1	2,065,666
Day Night	37 / 37	42 / 43	11 / 12	3 / 3	3 / 2	1 / 1	49 / 50

Notes:

- No significant day/night biases in yields, but...
January to May yields for Cases 1 & 2 shift by ~5%.
-Due to lost HSB or seasonal differences?
- About 12 percent of AIRS FOVs have AMSR, but no AIRS retrieval.



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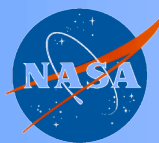
50S - 50N means can vary...

	AMSR Mean, Cases 1-3	Case 1	Case 2	Case 3	Case 4	Case 5
2003.12.25-2003.01.09		AMSR / AIRS	AMSR / AIRS	AMSR Only	AIRS MW only	AIRS Full Ret
Global Combined	29.0 mm	-1.6 / -2.7 %	1.6 / 1.0 %	14.0 %	0.3 %	-0.6 %
Day	30.6 mm	-2.0 / -1.9 %	-9.0 / -9.1 %	10.4 %	-3.6 %	-9.7 %
Night	27.6 mm	-1.2 / -3.6 %	10.8 / 9.8 %	17.3 %	3.7 %	8.6 %
2003.05.01-2003.05.16						
Global Combined	30.4 mm	2.2 / -1.8 %	4.6 / 1.3 %	10.5 %	1.1 %	2.8 %
Day	31.3 mm	0.7 / -1.4 %	-2.4 / -4.9 %	8.4 %	-2.7 %	-6.2 %
Night	29.4 mm	3.7 / -2.2 %	11.1 / 7.0 %	12.6 %	4.9 %	11.5 %

MW-only means always near AMSR mean.

AMSR-only always wetter
than AMSR mean.

**Full retrieval biases vary over $\pm 10\%$,
BUT track matched AMSR.**



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Global results suggest *local* differences, => Look at maps of differences.

- **Approach**

- Generate maps of mean water vapor for Cases 1-5
- Look at fractional differences in biases relative to AMSR-E means.

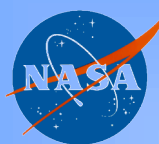
Biases we will see are due to *sampling differences*.

- ...so the fundamental retrieval methodologies appear sound

--BUT--

**Sampling biases in total water have important implications for
height-resolved climatologies from AIRS**

- ...though any data (AIRS) is better than little or none!

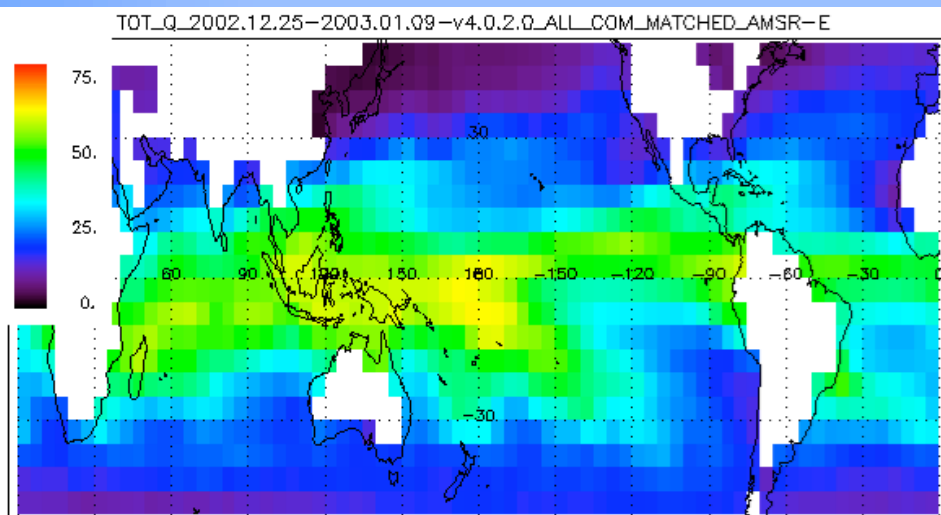


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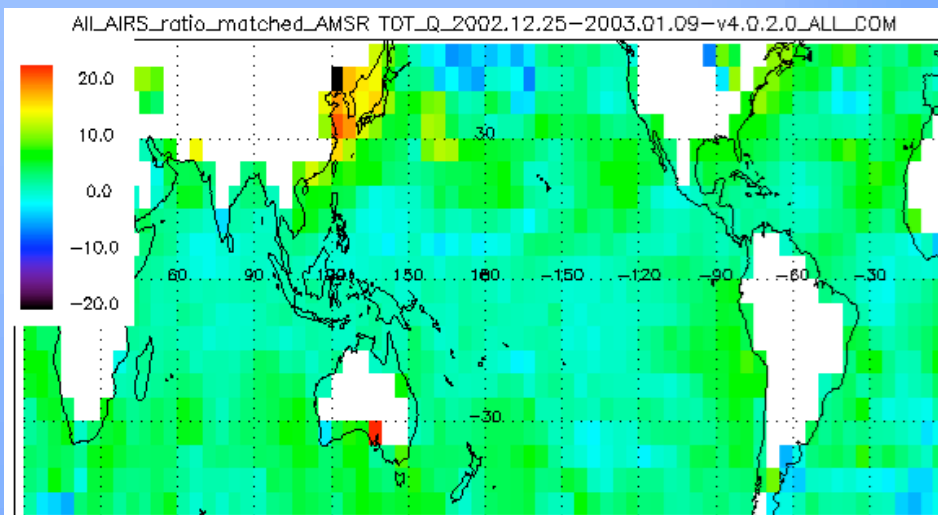
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Mean climatologies agree best with matched FOVs (Cases 1 and 2)

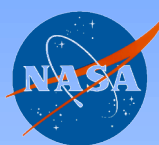


AMSR Mean (Cases 1 & 2)
16 days, winter 02-03



AIRS-AMSR Percent Difference

AIRS Qual_Cloud_OLR = 0 (Cases 1 & 2);
 $100. * [\text{Mean}(\text{AIRS}) - \text{Mean}(\text{AMSR})] / \text{Mean}(\text{AMSR})$



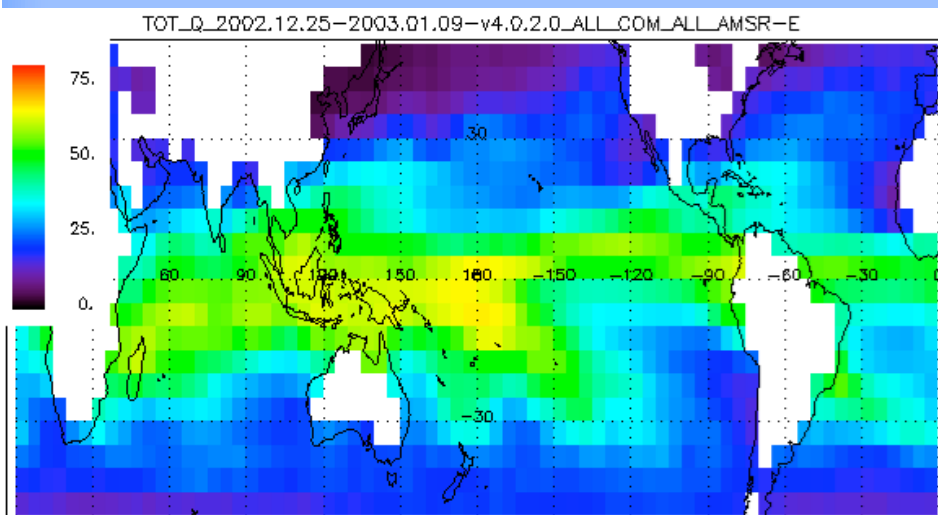
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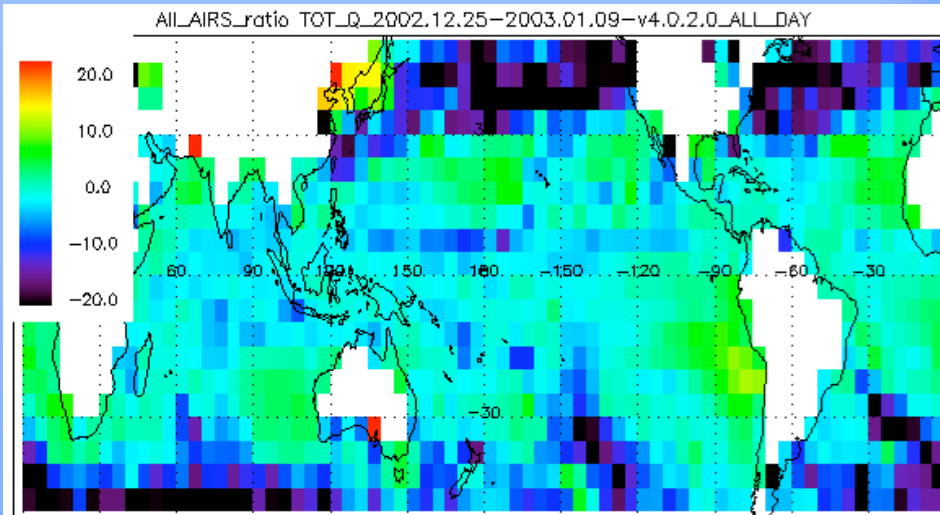


BUT, compare climatologies carefully...

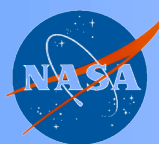
E. g., larger *regional* sampling biases for means
over all AMSR versus all AIRS



AMSR Mean, Cases 1-3
16 days, winter 02-03



AIRS Case 1 & 2 Percent Difference
Relative to AMSR to left

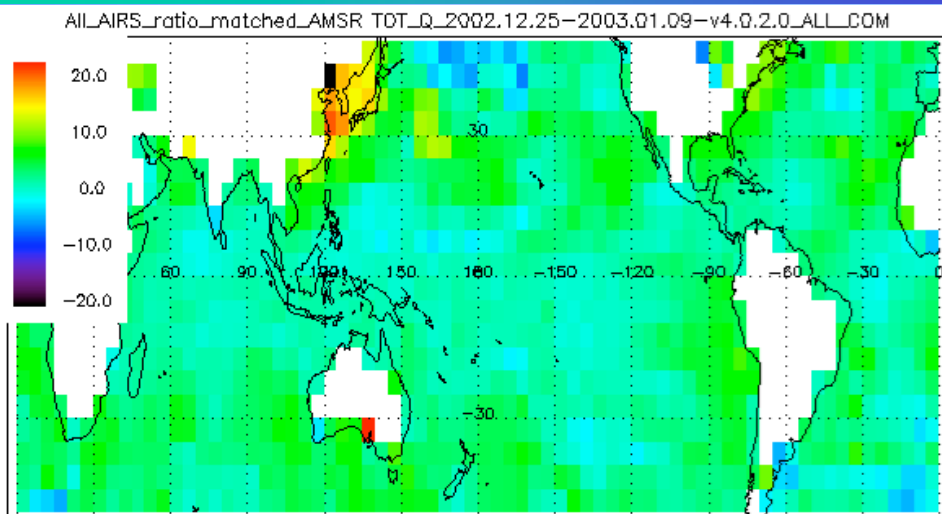


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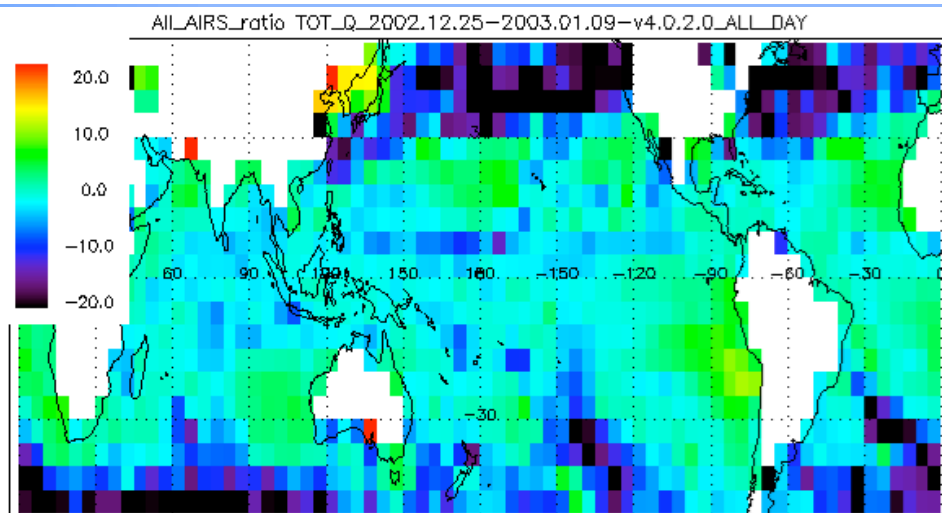
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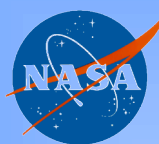
Rehashing last two comparisons: Case 3 matters, though only 12% of all FOVs!



**AIRS (Case 1 & 2) Percent Difference
Relative to Matched AMSR (Cases 1 & 2)**



**AIRS (Case 1 & 2) Percent Difference
Relative to All AMSR (Cases 1, 2 & 3)**



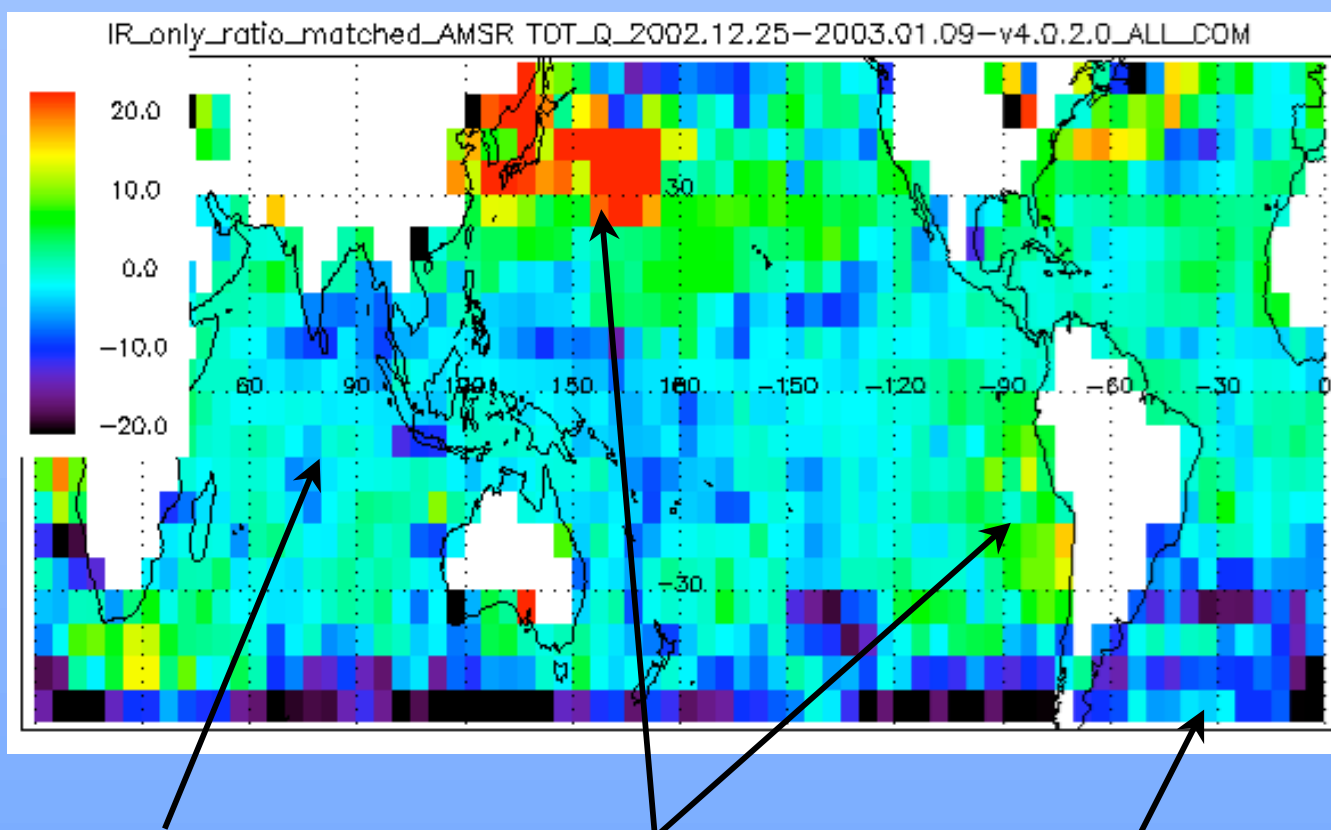
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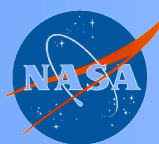


Comparing the 'best' from both instruments gives
large *regional* sampling biases.

AIRS full retrievals (Case 2) relative to All AMSR (Cases 1-3)



AIRS is: Mostly neutral to dry; WET in stratus regions; DRY in heavy clouds



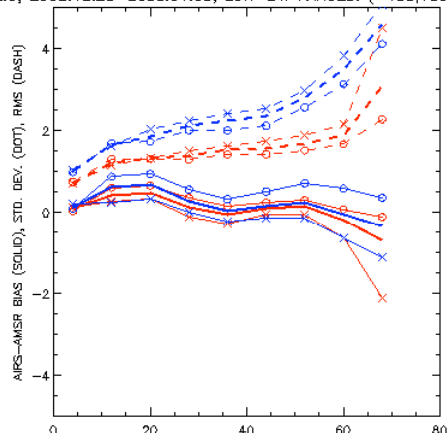
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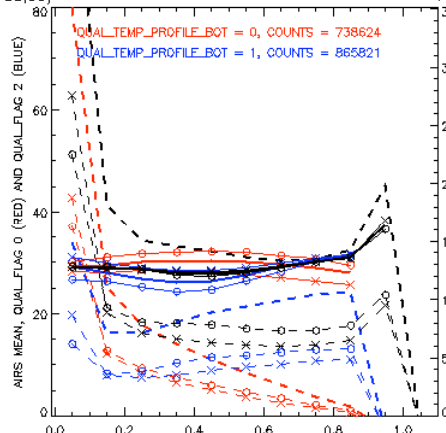


Differences by Total Water and Cloud Amount

0.2.0, 2002.12.25-2003.01.09, LON-LAT RANGES: (-180,180)-(-50,50)

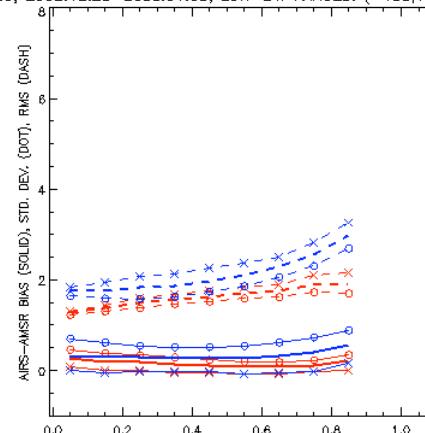


AIRS - AMSR TOT_D, LON-LAT RANGES: (-180,180)-(-50,50) STATS. (MM)

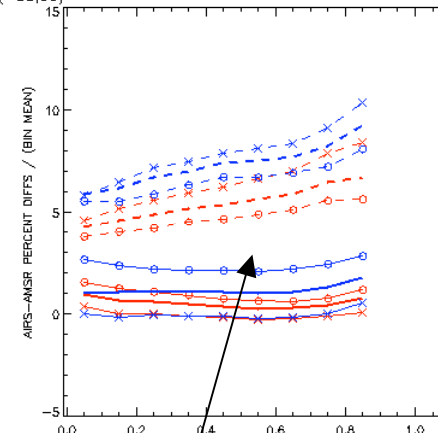


TOT_D, AIRS MEANS (MM) AND COUNTS

v4.0.2.0, 2002.12.25-2003.01.09, LON-LAT RANGES: (-180,180)-(-50,50)

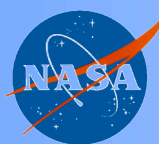


AIRS - AMSR TOT_D, LON-LAT RANGES: (-180,180)-(-50,50) STATS. (MM)



AIRS - AMSR TOT_D, LON-LAT RANGES: (-180,180)-(-50,50), (PERCENT)

**Conclusion: Cloud clearing does
not introduce biases by cloud amount,
and IR adds information.**



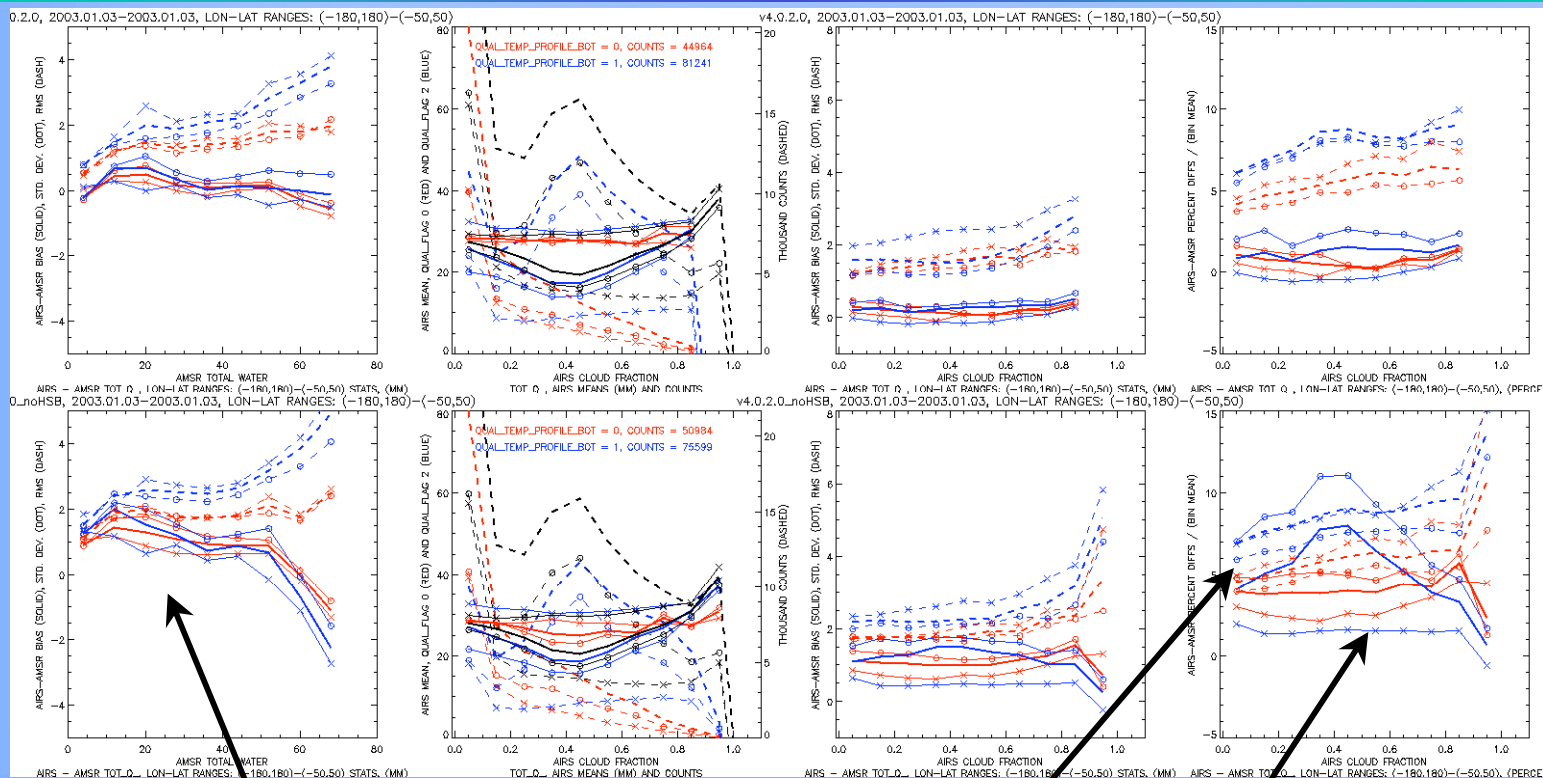
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Effect of Loss of HSB

50S- 50N, 3 Jan 2003

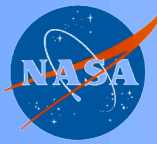


Conclusions. Loss of HSB leads to:

- 1) Amount-dependent biases
- 2) Strange effects during daytime
- 3) Greater biases and root-mean-squared differences

These need to be examined systematically with 16 days of retrievals.

Eric.J.Fetzer@jpl.nasa.gov, AIRS Science Team Meeting, 4-may-2005



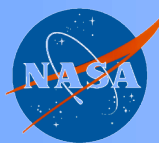
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Some Conclusions: Sampling Biases

- Globally, AIRS is slightly drier than *matched* AMSR-E.
 - --- but ---
- The local picture is more complex:
 - Full AIRS retrievals are *wetter* in stratus regions
 - MW adds some information in cold air outbreaks, but not in subtropical stratus
 - Hypothesis: stratus regions are cloudy and dry => AIRS not observing prevalent conditions.
 - Means over all AIRS retrievals are *drier* in midlatitude storm systems and other regions with high clouds
 - Hypothesis: high, thick clouds lead to fewer AIRS retrievals, and are correlated with wetter underlying atmospheric.
 - About 10% of AIRS oceanic FOVs have no AIRS retrievals, but include AMSR-E information. Most commonly seen in high-latitude storms. These (AMSR-only) FOVs are *wetter* than average.
 - Hypothesis: cloudier regions are wetter and more likely to be precipitating over an AMSU FOV => no AIRS / AMSU retrieval. AMSR-E better able to discern precipitating clouds.



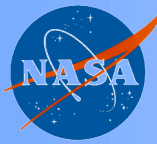
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Closing Remarks and Future Work

- **Cloud clearing:**
 - Cloud-cleared radiances have more information than microwave, based on RMS differences.
 - Full retrievals are not biased with cloud amount.
- **The loss of HSB leads to amount-dependent biases.**
 - Now comparing 16 days with and without HSB to better understand this.
- **Climatologies:**
 - A complete AIRS water vapor climatology (including one from profiles) will require careful interpretation by atmospheric state.
 - Atmospheric processes are a critical part of the interpretation.



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Next steps

- **Microwave Limb Sounder on Aura measures water vapor in the upper troposphere**
 - Potential for analyses like the AMSR-E comparison shown here, but for height-resolved water vapor.
 - Bill Read of MLS team has started this.
- **Annmarie Eldering is comparing AIRS and TES water vapor retrievals.**